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EASTMAN KODAK COMPANY
APPARATUS AND OPTICAL DIVISION

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LASER MATERIAL STUDY

Contract Nonr - 3834(00)

Semi-Annual Technical Report
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Prepared by

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For

ADVANCED RESEARCH PROJECTS AGENCY

and

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INTRODUCTION

The previous six month period represented the completion of the bulk of the work of this contract. Our purpose in gaining a time extension and proceeding at a low level of effort and expenditure was twofold: To try to resolve some unanswered technical problems relating the laser efficiencies of different glasses, and to keep in touch with the O.N.R. program systems requirements.

During the period of this report, much of our time was spent in adapting our glass plant procedures to handle silicate glass formulations of large enough size to give good optical quality. We have succeeded and are now producing sufficient quantity to make neodymium-doped silicate glass available commercially.

DISCUSSION

The basic problem of converting optical pumping energy to coherent laser output efficiently is a many sided one. It is in an attempt to shed some light on this problem that the present work is undertaken.

We have previously demonstrated in small rods that fluorescence efficiency is not a sufficient criterion to predict the laser performance of a neodymium doped glass.

Since our facilities for melting, stirring and casting do not allow us to prepare high temperature glasses, we have engaged the services of an outside vendor to prepare a cesium-barium silicate composition to our specifications. We have extended our in-house capability to provide a low melting lithium silicate glass as a second comparison for our standard borate material. This glass has been cast, annealed, ground and polished, but not yet coated and tested. Our next technical report will cover the results of the testing of this material.

So far, only a small melt of the cesium glass has been made for absorption and fluorescence measurements.

Table I summarizes some of the properties of the three glasses whose laser action we plan to investigate.

The rods for test are 12" long and 1/2" diameter, with a fine grind on the cylindrical surface.

Table II is similar to page 7 of our previous technical report (January 1 - June 30, 1963), but has corrected values for the compositions of glasses 2309 and 2310.

TABLE I

Type No.	Composition, Wt. %	Nd, Wt.%	Refractive Index (nD)	Density (gms/cc)	.8μ Absorption (cm^{-1})	Life-time (μsec)	.8μ Absorption per ion ($10^{-20} cm^2$)
ND-10	B 36.2, La 21.4, Si 2.4, Th 19.5, Sr 6.2, Ba 13.2	1.0	1.697	4.132	2.80	60	1.9
2305	Si 50, La 12, Li 7, Na 10, Sr 10, Ba 10	1.0	1.596	3.130	2.46	360	2.2
2311	Si 43.4, Cs 40.8, Ba 14.8	1.0	1.573	3.736	.93	546	.7

TABLE II

SILICATES

Glass No.	Composition by Wt. %	Nd	Refractive Index (nD)	Density (gms/cc)	Peak Absorption Coefficient (cm^{-1}) at 0.8μ	Life-time (μsec)	Absolute Absorption Cross Section /ion ($10^{-20} cm^2$) at 0.8 microns
2296	Si 40 - La 22 - Li 7 - Na 10 - Ba 20	1.0	1.6315	3.4471	2.76	336.7	2.240
2297	Si 42.5 - La 23.9 - Ce 0.5 - Na 10.6 - Ba 21.3	1.0	1.6182	3.5509	2.61	373.1	1.940
2298	Si 40 - La 13.5 - Ce 0.5 - Li 5 - Na 10 - Zn 10 - Ba 20	1.0	1.6253	3.4345	2.79	338.5	2.269
2299	Si 40 - La 13.5 - Ce 0.5 - Li 5 - Na 10 - Cd 10 - Ba 20	1.0	1.6325	3.5401	2.84	336.7	2.241
2300	Si 40 - Al 6.5 - Ce 0.5 - Li 7 - Na 10 - Zn 5 - Ba 20	1.0	1.5962	3.2207	2.43	354.9	2.107
2302	Si 50 - Al 3 - La 8 - Li 7 - Ti 1 - Na 10 - Sr 10 - Ba 10	1.0	1.5887	3.0817	1.89	359.5	1.711
2303	Si 50 - Al 3 - La 8.5 - Ce 0.5 - Li 7 - Na 10 - Sr 10 - Ba 10	1.0	1.5858	3.0853	2.01	382.2	1.819
2305	50 - 11.5 - 0.5 - 7 - 10 - 10 - 10	1.0	1.5959	3.1298	2.46	359.5	2.200
2309	Si 49.8 - Li 5.3 - Na 11.7 - K 16.7 - Mg 7.1 - Ca 9.9	1.0	1.5829	3.1022	1.60	354.9	1.455
2310	42.7 - 9.5 - 14.5 - 8.6 - Ba 23.6	1.0	1.5624	2.6422	1.57	336.7	1.676
2311	Si 43.4 - Cs 40.8 - Ba 14.8	1.0	1.5732	3.7363	0.93	546.0	0.702

FURTHER DEVELOPMENT

Our plan is as follows:

1. To measure output-input energy curves for the ND-10 borate and lithium silicate rods we have.
2. To measure passive absorption at 1.06 microns.
3. To compare efficiency of the rods with different output reflectors.
4. To secure a comparable rod of cesium silicate for similar tests. This will contain 2 wt. percent Nd, to make its absorption more like the other glasses.

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